USE OF A SPECTROPHOTOMETER OR FLUOROMETER TO DETERMINE AQUEOUS CONSTITUENT CONCENTRATIONS

PROCEDURE ID: YMP-LBNL-TIP/AFT 7.0 | REV.1, MOD. 0 | EFFECTIVE: 09/08/2000

1. PURPOSE

This Technical Implementing Procedure (TIP) provides instructions for using a spectrophotometer or fluorometer to determine the concentration of chemical constituents (which will absorb and/or fluoresce at a given wavelength) in liquid samples at Lawrence Berkeley National Laboratory (LBNL) for supporting the Yucca Mountain Site Characterization Project (YMP).

2. SCOPE

This procedure applies to all LBNL personnel (or contractor personnel following LBNL procedures) involved in the use of a spectrophotometer or fluorometer to determine concentrations of constituents in solutions for YMP activities subject to Quality Assurance Requirements and Description (QARD), DOE/RW-0333P. Prior to conducting work described in Section 3 of this procedure, personnel performing measurements require training to this procedure.

All technical activities, data collected using this procedure, and any instrument calibrations shall be in accordance with this TIP and in full compliance with YMP Administrative Procedure (YAP)-12.3Q, *Control of Measuring and Test Equipment and Calibration Standards*. All documentation resulting from actions taken under this TIP will be recorded in Scientific Notebooks and/or Equipment Logbooks (controlled as a supplemental record) as described in the Office of Civilian Radioactive Waste Management (OCRWM) Administrative Procedure (AP)-SIII.1Q, *Scientific Notebooks*.

If this procedure cannot be implemented as written, YMP-LBNL personnel shall notify the responsible Principal Investigator (PI) or designee. If it is determined that a portion of the work cannot be accomplished as described in this TIP, or would produce undesirable results, that portion of the work shall be stopped and not resumed until this procedure is modified per YMP-LBNL-QIP-5.2, *Preparing Development Plans & Quality /Technical Implementing Procedures*.

If the responsible PI or designee determines that a modification or a revision to the TIP would cause an unreasonable delay in proceeding with the task, then an expedited change to the procedure, including documentation of deviation from the approved procedure, can be made according to YMP-LBNL-QIP-5.2. Such changes are subject to review, usually after the task has proceeded, and thus work performed under TIPs with expedited changes is done at risk of future invalidation.

Employees may use a controlled electronic or hard copy of this procedure; however, employees are responsible for assuring that the correct revision of this procedure is used. When this procedure becomes obsolete or superseded, it must be destroyed or marked "superseded" to ensure that this document is not used to perform work.

3. PROCEDURE

3.1 Principle

A spectrophotometer or fluorometer measures the amount of light either absorbed or emitted (fluoresced) at a given wavelength by a constituent in solution. These instruments typically provide a response that is proportional to the concentration of the absorbing or fluorescing constituent in solution. A series of standards of known concentration are prepared to establish a calibration curve of concentration vs. response that can then be used to determine sample concentrations.

3.2 Equipment

The equipment associated with this TIP consists of:

(1) a spectrophotometer or fluorometer, which typically includes a light source, optical equipment (e.g., filters) to control incident or sensed wavelengths, light detectors / photomultiplier tube(s), and electronics to control the instrument and convert the sensed light intensity to a response

(2) test tubes or cuvettes to contain the samples

(3) a flow-through cell (on some models) that allows continuous monitoring of absorbance or fluorescence in a flowing stream, and an automatic sipper system to sip the samples into the flow cell for concentration determination, and

(4) temperature control equipment on some sophisticated models.

This list of equipment is not intended to be all-inclusive.

Labware used in this procedure shall be washed in the appropriate cleaning solution (e.g., LIQUI-NOX phosphate-free liquid detergent), rinsed three times with tap water, rinsed three times with reagent water, and air-dried at room temperature.

3.3 Samples

Liquid samples for spectrophotometer and / or fluorometer analysis may be from various sources, including (but not limited to) laboratory and / or field tracer

tests. Samples shall be controlled in accordance with YMP-LBNL-QIP-SII.0, *Documenting Sample Control*.

3.3.1 Sample Name / Bottle Labeling

Samples shall be collected in the appropriate containers (e.g., high-density polyethylene and / or glass bottles with tight sealing caps) deemed suitable for collection and storage of samples. Care shall be taken (e.g., wear gloves) to prevent cross-contamination during sample collection. Specific methods for sample collections shall be recorded in the scientific notebook. Each sample shall be given a unique identifier to reflect the sample source or an appropriate abbreviation thereof. Sample names shall be marked with an indelible marker either directly on the bottle or on an adhesive sticker affixed to the bottle along with the name of the originator and the date. The sample name, time and location of sample collection, and the unique identifier assigned by the Sample Management Facility (SMF) of the YMP (if applicable), in accordance with YAP-SII.1Q *Submittal, Review, and Approval of Requests for Yucca Mountain Site Characterization Project Geologic Specimens*, shall be entered into the scientific notebook.

Safety considerations associated with handling of chemicals will depend on the chemical nature of the constituents in the solutions. Material Safety Data Sheets (MSDSs) shall be consulted to determine whether special protective clothing and / or eye protection are required. A hazard label shall be placed on any sample bottle that contains hazardous chemicals.

3.3.2 Sample Handling / Preservation

For samples collected from the laboratory work, they shall be refrigerated before analysis. For samples collected from field sites, refrigeration after sample collection and during sample transfer to the LBNL may not be feasible. Dependent upon the characteristics of the samples, alternative steps (e.g., as putting the ice packs together with the samples during sample storage and transfer) shall be taken, at the discretion of the responsible PI or designee, to mitigate potential sample degradation. The method of preservation shall be recorded in the scientific notebook.

Samples shall be stored such that the impact of storage on the sample integrity is minimized. For example, if a light-sensitive constituent is to be analyzed (e.g., a fluorescent dye such as fluorescein), the samples shall be stored in darkness and / or in opaque bottles. Special handling requirements for different constituents shall be considered on an individual basis. Such special handling steps shall be recorded in the scientific notebook.

With the above stated sample handling requirements, samples shall be analyzed within three months of collection. If samples cannot be analyzed within this timeframe, they shall be analyzed at the first available opportunity, and a notation shall be placed in the scientific notebook identifying the duration samples have exceeded the analysis timeframe (obtained from sample collection date recorded on the collection bottle and the analysis date). A notation shall also be placed on the analysis results allowing special consideration to be given to data generated, and an analysis of the data applicability. This analysis shall be documented in the scientific notebook.

3.4 Implementing Procedure

3.4.1 Identification of Standards to be Used

In accordance with YAP-12.3Q, the Measuring and Test Equipment (M&TE) Justification form (Attachment 1) shall be documented for each standard used and filed in the scientific notebook.

A. NIST-traceable standards: The calibration standards, when available, shall be traceable to nationally recognized standards [e.g., National Institute of Standards and Technology (NIST)], and procured from YMP-approved contractors on the Qualified Suppliers List (QSL), or an alternative approach within an Activity Evaluation shall be pursued according to AP-2.21Q, *Quality Determinations and Planning for Scientific, Engineering and Regulatory Compliance Activities*.

B. Non-NIST-traceable standards: Under most circumstances for spectrophotometer and/or fluorometer analysis, NIST-traceable standards are not available or cannot be obtained within the holding time of necessary measurement. In such cases, high-purity chemicals, such as reagent grade chemicals that conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society (ACS) (American Chemical Society Specifications, 8th edition, 1993), shall be used as the "standards" and the ratio approach described below will be used. Both food and fluorescent dyes have been commonly used in the Ambient Field Testing (AFT) projects; the color additives of the food dyes are customarily certified by the Food and Drug Administration (FDA). Verification of traceability to ACS or FDA shall be demonstrated by a certificate of analysis (e.g., on the chemical bottle) provided by the manufacturer or vendor.

Approaches using ratios shall be employed to present the data when NIST-traceable standards are not available. Such approaches are appropriate to the laboratory and/or field tracer tests, where relative

comparison may be sufficient. For example, the measured instrument response of the collected sample is divided by the response of the released tracer sample, with the instrument responses obtained using the "standards" (see Section 3.4.2A for preparation of "standards"). In employing this ratio approach, the chemicals used for the released samples (and hence the collected samples) in the tracer tests and used for making "standards" shall be from the same chemical source (e.g., the same bottle).

With the ratio approach, the results are independent of the purity, as well as sources, of chemicals used. Such approaches will limit the applicability of data, however, as only the relative comparison (instead of the absolute amount/concentration of the analyte) is obtained. Such approach, if used, shall be documented in the scientific notebook.

If NIST-traceable standards become available and can be obtained within the holding time of the samples, comparison runs shall be performed between the non-NIST-traceable and the NIST-traceable standards, with explanation of these results and acceptability of results described in the scientific notebook. If the non-NIST-traceable "standards" are acceptable, the absolute amount/concentration of the analyte generated based on such "standards" will be regarded as being qualified.

3.4.2 Preparation of Standard Solutions

A. Starting standards shall be either (1) obtained by using the NIST-traceable stock solutions with their concentrations stated (e.g., 1,000 mg/L) (see Section 3.4.1A), or (2) prepared by dissolving solid chemicals (See Section 3.4.1B) in reagent water, using a calibrated analytical balance and calibrated volumetric glassware (discussed in this subsection).

Obtain the starting "standard solution(s)" by weighing an amount of chemical and dissolving it in a known amount of water. Usually, concentrations of 1,000 mg/L and/or 100 mg/L for the "standards" are good working starting solutions. When weighing the amount of chemical "standard", avoid using small weights close to the balance precision. Record the chemical weight and liquid volume in the scientific notebook. If the chemical has low aqueous solubility (e.g., 70 mg/L), choose a concentration of the starting "standard solution" that is close to (but still lower than) the solubility limit (e.g., 50 mg/L), and use a relatively large volume of water (e.g., 0.05 g chemical dissolved in 1 L water, instead of 0.005 g chemical dissolved in 0.1 L water). Record the chemical weight and liquid volume in the scientific notebook.

Calibrate the balance in accordance to YMP-LBNL-TIP/AFT-1.0, *Balance Calibration*. Verify the accuracy of volumetric flasks, pipettes and pipettors by weighing water quantities delivered (pipettes, pipettors) or contained (flasks) using a calibrated balance. Discard flasks, pipettes and pipettors that show larger than 1% of its nominal volume.

B. Use the serial dilution technique, a widely recognized and accepted method of preparing standards, to obtain a set of standard solutions that span the expected range of concentrations in the samples or the instrument response. For each dilution step, use the pipette and/or pipettor to take the appropriate volume of starting standard solution into a volumetric flask and fill the water to the calibration line of the flask. Mix the solution thoroughly. Repeat the dilution until the desired concentration is obtained. For example, pipet 10 ml of 100 mg/L solution into a 100 ml volumetric flask and fill with water will produce a 10 mg/L solution.

Record in the scientific notebook steps taken to make serial dilution, i.e., the volume pipetted and size of volumetric flasks.

C. Prepare a label indicating the chemical's name and concentration, preparation date, preparer's initial, and attach the label to the individual container of standard solutions.

3.4.3 Preparatory Verification

A. Warm up the instrument for at least half an hour. Ensure that all sample test tubes or cuvettes are clean and free of fingerprints prior to being used, as any dirt or oil could cause errors or inconsistencies in the measurements.

B. Adopt one or a combination of the following methods to obtain maximum/optimal measurement wavelength by using a standard with the concentration high enough to have instrument response.

- For a spectrophotometer, adjust the wavelength setting until the maximum absorbance is obtained, or scan the standard to choose a peak response as the optimal measurement wavelength.

- For a fluorometer, adjust the excitation wavelength setting first to obtain the best response, and then adjust the emission wavelength setting independently until the maximum reading is obtained. Or scan the standard to obtain the optimal measurement wavelengths.

- Alternatively, obtain the maximum / optimal wavelength from published sources and document them in the scientific notebook. The optimal wavelength settings may not correspond exactly to the published literature, but they should generally be within a few percent of the published values.

C. Record the working excitation and / or emission wavelengths in the scientific notebook. Set up chemical analysis protocols (e.g., including the excitation and / or emission wavelengths) for repetitive measurements. If such protocols are used, document them in the scientific notebook.

3.4.4 Calibration and Sample Measurement Method

A. Conduct the calibration using a series of standard solutions that span the expected range of concentrations of the samples or the instrument response (refer to Section 3.4.2 for preparation of standard solutions). First introduce the standard solution of the lowest concentration (e.g., could be a blank of reagent water), and then use standards of increasing concentration until the highest standard solution or the response of the instrument is exceeded. For each concentration introduced, record the response of the instrument in the scientific notebook. Use a minimum of four concentrations of standard solutions to establish the calibration curve and determine the correlation coefficient (e.g., use the built-in functions in Microsoft Excel). In order for the calibration curve to be acceptable, the correlation coefficient (R^2) must be equal to or greater than 0.998. If the data does not meet this criterion, actions shall be taken to correct the problem [e.g., rerun or remake the standard(s), check / modify the experimental conditions, check the instrument].

If sample concentrations are low, obtain a reading using a blank that consists of the sample solution matrix with no target constituent present. This will establish a lower detection limit, and it will also establish whether there are any interfering constituents in the solution that absorb or fluoresce at the same wavelength as the target constituent. Record the findings in the scientific notebook if the interference affects the concentration measurements of target species, and other methods (e.g., chromatography separation) that may be used for sample measurements.

B. Perform the calibration at the beginning of a set of sample measurements and verify the calibration at the end of the set (or at intervals determined to be appropriate by the PI or designee based on experience with the instrument) to check for instrument drift. Record the results and times of all calibrations in the scientific notebook.

C. Once a calibration curve is established, initiate the measurement of samples (refer to Section 3.3 for control of samples) and record results in the scientific notebook. Depending upon the constituent concentration present in the samples, dilute samples appropriately until the final solution measurement falls within the calibration curve. Record all dilutions, if applicable, in the scientific notebook. Use the calibration curve to determine the sample concentrations given their readings.

D. General Considerations

Listed below are some steps and precautions that are commonly considered using a spectrophotometer and/or fluorometer.

(1) Sample Introduction

Only use clean test tubes or cuvettes. Take great care (e.g., only touch the top part of cuvettes, wear gloves) to not introduce dirt or fingerprints on the outside of the test tubes or cuvettes, as they can block or absorb some of the incident light and thus cause errors in the measurements. In case of noticeable presence of fingerprints on the outside of test tubes or cuvettes, wipe them with a lint-free towelette prior to using them.

In cases when test tubes or cuvettes will be used repeatedly to conduct a series of measurements, take care to ensure that there is no cross-contamination or carryover of one sample to the next. After emptying a sample out of a test tube or cuvette, rinse the test tube/cuvette thoroughly with a blank solution (e.g., a solution with no absorbing/fluorescing constituent, such as reagent water). Rinse the test tube/cuvette at least twice with the next solution to be analyzed to ensure that the blank solution has been removed and does not dilute the sample. Then dispense the sample into the test tube/cuvette and take a measurement.

If the auto sipper is used, before the next sample is introduced, thoroughly wash the flow cell by sipping reagent water until the instrument's response is that of the previously measured blank solution.

(2) Filtration

If the samples contain suspended particulate matter (e.g., observed to be turbid), filter the samples prior to introducing them to the instrument, because the particulates can scatter the incident or emitted light and cause measurement errors. Filtration can be accomplished

by any means that does not introduce interfering contamination or cross-contamination between samples or alter the concentration of the target species. Choose filtration media and labware to avoid sorption of constituents of interest. Document the method and materials, if applicable, in the scientific notebook.

(3) Instrument Drift

Repeat calibrations at the beginning and end of a run of sample measurements (or at intervals determined to be appropriate by the PI or designee based on experience with the instrument) to check for instrument drift. Record the results and times of all calibrations in the scientific notebook. If significant drift occurs between calibrations, decide whether it is necessary to repeat the measurements made since the last calibration. In general, a drift of more than 5% is considered excessive, and serious consideration shall be given to repeating the measurements. Document the decision and the rationale of whether or not to repeat measurements in the scientific notebook. If sample volumes are limited, account for drift by averaging two successive calibration curves that bracket the measurements. Document any corrective actions taken in the scientific notebook.

(4) Measurement Precision

Repeat measurements on a given solution (standard or sample) at least three times over the course of all measurements so that a statistical measure of precision (e.g., standard deviation) can be estimated.

(5) Environmental Conditions

Measurements are most consistent and reproducible when samples and standards are measured at the same temperature. If all solutions (standards and samples) cannot be kept at a constant temperature, at least allow them to equilibrate at the same temperature (e.g., room temperature) before the measurements.

3.4.5 Documentation of Sample Measurement Results

The following information shall be documented for each set of measurements:

a) The unique identifier of the instrument(s) used (e.g., manufacturer's name, model number, and serial number),

b) Instrument settings for the measurements (e.g., the wavelength settings),

c) The identity and concentration of all standards,

d) The identity of samples,

e) All instrument readings obtained, including those for samples and standards (calibrations),

f) The times at which calibrations were conducted, and

g) Change of environmental conditions (e.g., temperature), if any, over the course of the measurements.

3.4.6 M&TE Storage and Handling

M&TE shall not be handled in a manner that adversely affects its current or future performance. M&TE shall be used in laboratory environments, and stored at room temperature.

3.4.7 Identification of Tolerances and Ranges of Use

Calibration curves shall be used to define the range of use and tolerances for a spectrophotometer or fluorometer. The correlation coefficient (R^2) value of the calibration curve shall define the tolerance. In order for the calibration curve to be acceptable, the R^2 must be equal to or greater than 0.998.

3.4.8 Identification of Calibration Intervals

Calibration shall be performed each day samples are analyzed (Section 3.4.3).

3.4.9 Calibration Documentation

In accordance with YAP-12.3Q, staff members shall document the M&TE calibration on the M&TE Calibration Documentation Form (Attachment 2).

Calibration is required each day samples are analyzed as calibration is an integral part of the measurement procedure. A calibration sticker containing the following information shall be affixed to the instrument.

Calibration
By: LBNL staff following the TIP for calibration.
This instrument shall be calibrated each day samples are analyzed.
Instrument S/N:

Copies of the calibration results shall be provided to the LBNL M&TE Coordinator to update the M&TE list as per YAP-12.3Q.

3.4.10 Controls for Out-of-Calibration Conditions

If any out-of-calibration conditions (as described in YAP-12.3Q) are determined to exist for the M&TE item (e.g., instrument produces results known to be in error), the instrument shall have an out-of-service tag applied indicating that it is not to be used and, when possible, the instrument shall be moved to a segregated "out-of-service" area.

The above conditions shall be documented by using the M&TE Out of Calibration Report (OCR) in accordance with the instructions provided in YAP-12.3Q. If it is determined that the data is impacted, a Nonconformance Report (NCR) shall be initiated in accordance with YAP-15.1Q, *Control of Nonconformances*.

3.4.11 Recalibration When Updates to Software Contained Affects Calibration

All software used in M&TE is integral to the M&TE. Software updates will not affect the previous calibrations as calibration is required each time samples are analyzed.

3.4.12 Usage of M&TE

Staff Member shall document each usage of the equipment in the scientific notebook (containing the same information as described in YAP-12.3Q) or the M&TE Standard Usage Log as described in YAP-12.3Q.

3.5 Potential Sources of Error and Uncertainty

Potential sources of error and uncertainty may involve:

- not allowing enough time for the instrument to warm up and stabilize,
- dirt or fingerprints on test tubes or cuvettes, particulates in the samples,

- cross-contamination between samples as a result of not thoroughly rinsing out the test tubes or cuvettes between measurements,
- improper storage of samples such that the constituents sorb to container walls, degrade or are otherwise comprised,
- incorrect recording of the instrument's readings,
- difference in temperature between standards and samples,
- poor preparation of standards used for calibration, and
- the presence of interfering constituents (i.e., constituents that give a response similar to the target constituent) in the samples that are not present in the calibration standards.

4. RECORDS

4.1 Lifetime

Records generated as a result of this TIP are entries in:

- Scientific notebooks or attachments to such notebooks,
- Equipment Logbooks (including M&TE Standard Usage Log, if applicable).

4.2 Non-Permanent

None

4.3 Controlled Documents

This Technical Implementing Procedure

4.4 Records Center Documents

Records associated with this procedure shall be transmitted to the Records Coordinator for submittal to the Records Processing Center (RPC) in accordance with AP-17.1Q, *Record Source Responsibility for Inclusionary Records*.

5. RESPONSIBILITIES

5.1 The Principal Investigator (PI) is responsible for assuring full compliance with this procedure and providing training thereof. The PI is responsible for overseeing and coordinating the preparation, review, distribution, revision, and recommending rescission of the TIP.

5.2 Staff Members are responsible for following this procedure and turning over related documentation to the Records Coordinator for submittal to the RPC in accordance with AP-17.1Q. Related data shall be turned over to Technical Data Coordinator for entry into the YMP Technical Database Management System (TDMS) in accordance with YMP-LBNL-QIP-SIII.3, *Submitting Key Data to the Yucca Mountain Project Office*.

6. ACRONYMS AND DEFINITIONS

6.1 Acronyms

ACS	American Chemical Society
AFT	Ambient Field Testing
AP	OCRWM Administrative Procedure
EA	Engineering Assurance
FDA	Food and Drug Administration
LBNL	Lawrence Berkeley National Laboratory
M&TE	Measuring and Test Equipment
MSDS	Material Safety Data Sheet
NCR	Nonconformance Report
NIST	National Institute of Standards and Technology
OCR	Out of Calibration Report
OCRWM	Office of Civilian Radioactive Waste Management
OQA	Office of Quality Assurance
PI	Principal Investigator
QIP	Quality Implementing Procedure

RPC	Records Processing Center
SMF	Sample Management Facility
TDMS	Technical Data Management System
TIP	Technical Implementing Procedure
YAP	YMP Administrative Procedure
YMP	Yucca Mountain Site Characterization Project

6.2 Definitions

Fluorometer: An instrument that is capable of focusing a light beam of a specified wavelength or wavelength range on a sample containing a constituent that is excited by the light. The excited constituent then emits light at a different (longer) wavelength than the incident light; this process is called fluorescence.

Spectrophotometer: An instrument that is capable of focusing a beam of light of a specified wavelength or wavelength range on a sample containing a constituent that absorbs the light to some degree. The instrument often measures the absorbance of light by splitting the light beam (using optics) and comparing the amount of light transmitted through the sample to the amount of light transmitted through a sample that does not contain the light-absorbing constituent (a blank).

Staff Member: Any scientist, engineer, research or technical associate, technician, or student research assistant performing quality-affecting work for YMP-LBNL.

Technical Implementing Procedure: Each TIP describes YMP-LBNL technical tasks that (1) are repetitive, and (2) are standardized.

7. REFERENCES

AP-17.1Q, *Record Source Responsibility for Inclusionary Records*

AP-2.21Q, *Quality Determinations and Planning for Scientific, Engineering and Regulatory Compliance Activities*

AP-SIII.1Q, *Scientific Notebooks*

AP-SIII.3Q, *Submittal and Incorporation of Data to the Technical Data Management System*

DOE/RW-0333P, *Quality Assurance Requirements and Description*

Reagent Chemicals: American Chemical Society Specifications. 8th edition, official from April 1, 1993. American Chemical Society, Washington, DC, 1993.

YAP-12.3Q, *Control of Measuring and Test Equipment and Calibration Standards*

YAP-15.1Q, *Control of Nonconformances*

YAP-SII.1Q, *Submittal, Review, and Approval of Requests for Yucca Mountain Site Characterization Project Geologic Specimens*

YMP-LBNL-QIP-5.2, *Preparing Development Plans & Quality/Technical Implementing Procedures*

YMP-LBNL-QIP-SII.0, *Documenting Sample Control*

YMP-LBNL-TIP / AFT-1.0, *Balance Calibration*

8. ATTACHMENTS

Attachment 1: M&TE Justification Form.

Attachment 2: M&TE Calibration Documentation Form.

9. REVISION HISTORY

09/30/98 - Revision 0, Modification 0:

This TIP was initially a part of scientific notebook procedure/methodology prepared by Qinhong (Max) Hu on 06/04/98, and documented in the scientific notebook YMP-LBNL-JSW-QH-1A.

09/08/00 – Revision 1, Modification 0:

Revised the procedure to meet YAP-12.3Q requirements and incorporate references to other applicable APs and YAPs.

10. APPROVAL

Signature on file

Preparer: Qinhong (Max) Hu Date:

Signature on file

Technical Review: Timothy J. Kneafsey Date:

Signature on file

Technical Review: Peter Persoff Date:

Signature on file

EA Reviewer: Nancy Aden-Gleason Date:

Signature on file

OQA Concurrence: Stephen Harris Date:

Signature on file

Principal Investigator: Joseph S.Y. Wang Date:

Signature on file

Project Manager: Gudmundur S. Bodvarsson Date:

YMP-335-R0
07/30/1999

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
MEASURING AND TEST EQUIPMENT
JUSTIFICATION

QA:
Page:____ Of:____

1. M&TE ID No.:	2. M&TE Type:

3. Initiator Name:	4. Date:	5. Responsible Manager or Principle Investigator:

6. Justification:

7. Approved By:

Responsible Manager or Principle Investigator: _____ Date: _____
Printed Name

_____
Signature

M&TE Calibration Documentation Form

<table>
<tr><td>a) M&TE description</td><td>b) M&TE unique identification</td><td>c) Calibration date and time (if applicable)</td></tr>
<tr><td colspan="2">d) Person performing calibrations</td><td>e) M&TE condition (as-found)
Working _____

Not working _____</td></tr>
<tr><td colspan="2">f) Calibration procedure (including revision level)</td><td>g) Calibration standards used</td></tr>
<tr><td colspan="2">h) Location of calibration data

YMP-LBNL-_____
Page(s):</td><td>i) Location of calibration results

YMP-LBNL-_____
Page(s):</td></tr>
<tr><td colspan="3">j) Specified range and tolerances</td></tr>
<tr><td colspan="3">k) Statement of acceptability including acceptability of range and tolerances
Range acceptable Yes _____, No _____
Tolerance acceptable Yes _____, No _____
Calibration acceptable Yes _____, No _____
Comments:</td></tr>
<tr><td colspan="2">l) Re-calibration due date or calibration interval/frequency</td><td>m) Reference to actions taken with out-of-calibration or non conforming M&TE, including evaluation results, as appropriate

YMP-LBNL-_____
Page(s):</td></tr>
<tr><td colspan="3">n) Comments</td></tr>
</table>

Signature Date